INDUSTRIAL WATER USE IN NORTH CAROLINA

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U.N.C. WATER
RESOURCE PAPERS
Number 13

INDUSTRIAL WATER USE IN NORTH CAROLINA

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Assisted by a grant from the
United States Public Health Service

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University of North Carolina
Chapel Hill September 1964

U.N.C. WATER RESOURCE PAPERS
Number 13.

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FOREWORD

This is one of a series of papers that was instituted as a vehicle for a three-year research project concerning water use in North Carolina, undertaken at the Institute of Government in 1962 with the help of a grant from the United States Public Health Service. The previous publications in this series were concerned with irrigation. With this paper we move into another area, industrial water use, and this is the project's principal publication on that subject.

This paper is largely the product of field investigations by William Walker in the summer of 1963 and is based on a master's thesis in Sanitary Engineering which he completed in 1964.* He came to this task admirably qualified by an unusual combination of engineering, legal and business experience.** Walker's main objectives were to identify the major industrial water users in North Carolina, to investigate the extent and nature of their water uses, and to explore their legal arrangements and problems in securing sources of water. His report furnishes a foundation for understanding the industrial water supply economy of the state and should serve as a benchmark for further studies.

My reading of this report leaves me with several leading impressions. One is that, by-and-large, legal aspects of water supply arrangements are rarely of pressing concern to industrial management in North Carolina. If this is true from a consideration of the fifty-plus major water users in the State, it is quite likely to hold true for the less water-oriented firms.

A corollary of this finding, I suspect, is that the industrial manager who is confronted with a water law problem involving his business may be vulnerable to misinterpreting the problem or to overemphasizing

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*In partial fulfillment of the requirements for the degree of Master of Science in Sanitary Engineering in the Department of Environmental Sciences and Engineering, University of North Carolina.

**B.S., 1949, LLB, 1952, M.S., 1964, formerly associated with United States Gypsum Company, Portland Cement Association and Institute of Government and presently Assistant Professor of Civil Engineering at Virginia Polytechnic Institute.

its significance because of unfamiliarity. We hope in this report to dispel some of the mysteries.

A related conclusion is that water supply costs, including expenditures for water rights, are in most cases a minor part of over-all industrial production costs in North Carolina, even among the more water-oriented industries that were the subject of this study. As Walker's report shows, large variations in relative water supply costs are apparently tolerable as between firms in the same industry.

Undeniably in a few cases expenses of water supply or waste disposal may be a significant cost element. The problems of a few plants, however, should not be misidentified as those of industry generally, nor should cures for such problems necessarily be designed as if they were directed to industry as a whole.

In closing, I want to express my great appreciation for the many courtesies and excellent co-operation extended to Mr. Walker by the industrial officials he interviewed. Their very generous help was indispensable to the completion of this study.

Milton S. Heath, Jr.

INDUSTRIAL WATER USE IN NORTH CAROLINA

This is primarily a report on industrial water use in North Carolina although it does include a discussion of industrial waste effluents as they relate to and influence the availability of water for other users. It attempts to appraise such items as quantity of water currently being used, the importance of water quality, extent to which water is reused, the impact of state regulation of stream quality standards, importance of power generating facilities on, and the relationship between industries and other water users. All statements in the report concerning such matters as quantity of water used, cost of water supply and waste disposal, and litigation concerning water use are based exclusively on information supplied by officials of the firms interviewed unless otherwise noted.

The companies studied were principally those with independent ground and surface water sources. Firms are included which use municipal water when their industrial waste discharge is not to a municipal treatment plant and the effluent is of such magnitude and of a type which contravenes existing stream classifications.[1]

The location of water within this state or any state does not afford all users the opportunity of first use. Geographic location and economic necessity require that there be many re-uses of water by individuals, business entities and governmental institutions. The extent to which economic methods can be discovered for treating industrial waste or providing adequate water for dilution of waste effluents may materially influence future industrial expansion.

In the past a significant part of North Carolina's industrial development has been in the "wet" industry field (textile and paper). Although water may not have been a dominant factor in the selection of site locations, the availability of large quantities of good quality water was an absolute necessity for the plants to function. Industrial expansion in

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[1]Whitfield, J. V., et al., Classification and Water Quality Standards Applicable to Surface Waters of North Carolina.

more recent years has included the food processing and mining industries which have water requirements not comparable to the strictly "wet" industries. Their industrial waste discharge has had significant influence on the availability of good process water.

The specific purpose of the study underlying this report is to determine

(1) the practices of industry with respect to water and waste water disposal,
(2) existing or potential conflicts between water users,
(3) the availability of water as a significant factor in industrial development,
(4) the effect of existing laws and administration policies regarding water resources, and
(5) the relationship between water source and type of industrial development.

Industries Selected

The industries selected for this study were taken from those listed in the sixteen river basin studies made by the State Stream Sanitation Committee[2] and from a list of industries which have located in North Carolina subsequent to these basin studies. The latter list was compiled by consultation with Renno J. Hawkins[3] of the North Carolina Department of Conservation and Development.

This paper could not be limited to a geographic region of the state if a significant number of all the major industries were to be included. Thus, industries were selected on the basis of ground water use, surface water use, and industrial waste disposal problem. The number of firms to be contacted was limited to ground water users with a minimum water requirement of 100,000 gallons a day, to surface water users requiring more than a million gallons of water per day, and to industries with a waste disposal problem having a magnitude of 5,000 population equivalent.

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[2]Pollution Survey Reports, North Carolina State Stream Sanitation Committee, Department of Water Resources, Division of Stream Sanitation and Hydrology.

[3]Renno J. Hawkins, Chief, Research and Statistics Section.

Officials of fifty-three companies were interviewed. Several of these companies had more than one plant in North Carolina with water requirements or waste water discharges meeting the criteria for inclusion in this report. Three examples are Burlington Industries Incorporated with twelve operating plants or subsidiaries, Cone Mills with seven plant locations and Superior Stone Company with twenty operating units. The following is a tabulation of the number of companies studied in each industry classification:

Paper and Pulp	7
Textiles	22
Electric Power	3
Electrical Equipment	2
Food Processing	13
Mining and Quarrying	3
Miscellaneous	3

A mail survey was conducted among companies which have private hydroelectric generating facilities to determine the present status of these facilities and the water rights attendant thereto.

Although the number of companies studied is not large it does include the firms which use substantially all the industrial surface water and a large per cent of the ground water from private sources. It also includes the companies which discharge a significant portion of all the industrial waste water received by streams from private sources. Table I shows in detail the per cent of the total industrial surface water, industrial ground water and industrial pollution included in this study. This comparison is possible since the Pollution Survey Reports of the State Stream Sanitation Committee provide data in terms of these parameters.

Some plants with large industrial wastes obtained their water from municipal sources while other plants had private water sources but discharged their wastes into municipal sewers. These circumstances enlarged the number of firms contacted and caused a slight deviation from the original plan, which was to include only firms with private water sources and which disposed of their own industrial waste.

Tobacco, furniture, wood products and wearing apparel which represent four large segments of North Carolina's total industrial complex were excluded from this survey since their manufacturing processes are not primarily dependent on water. The water these companies need for domestic purposes and incidental manufacturing processes can be easily met from a small private source or a municipal supply.

TABLE I

PER CENT OF WATER USING INDUSTRIES
STUDIED BY RIVER BASINS

(Total Water Use and Industrial Waste for River Basin was based on Pollution Survey Reports by the State Stream Sanitation Committee)

River Basin	Industrial Surface Water Use Covered by Study (Per Cent)	Industrial Ground Water Use Covered by Study (Per Cent)	Industrial Waste Covered by Study (Per Cent)
Yadkin	*	***	49
White Oak	**	**	**
Chowan	**	**	**
Roanoke	99	***	98
French Broad	99	***	96
Cape Fear	99	99	84
Neuse	89	99	45
Pasquotank	**	**	**
Little Tennessee	99	***	99
Hiwassee	**	**	--
Catawba	86	20	73
Tar-Pamlico	--	--	--
Broad	95	33	33
New	--	--	--
Watauga	**	**	**
Lumber	99	64	79

*Pollution survey report for this basin indicated that the record was not complete.

**No significant water using industry in this river basin.

***Industries visited used surface water only.

The "tourist industry," reputed to be the third largest industry in the state, is to an extent water oriented. A UNC Water Resource Paper on recreation, scheduled for publication late in 1964, will discuss the "tourist industry" in terms of water resources development. In some areas of the state the amount of industrial water use and the degree of treatment given industrial waste water will have distinct bearing on the continued growth of this segment of the economy.

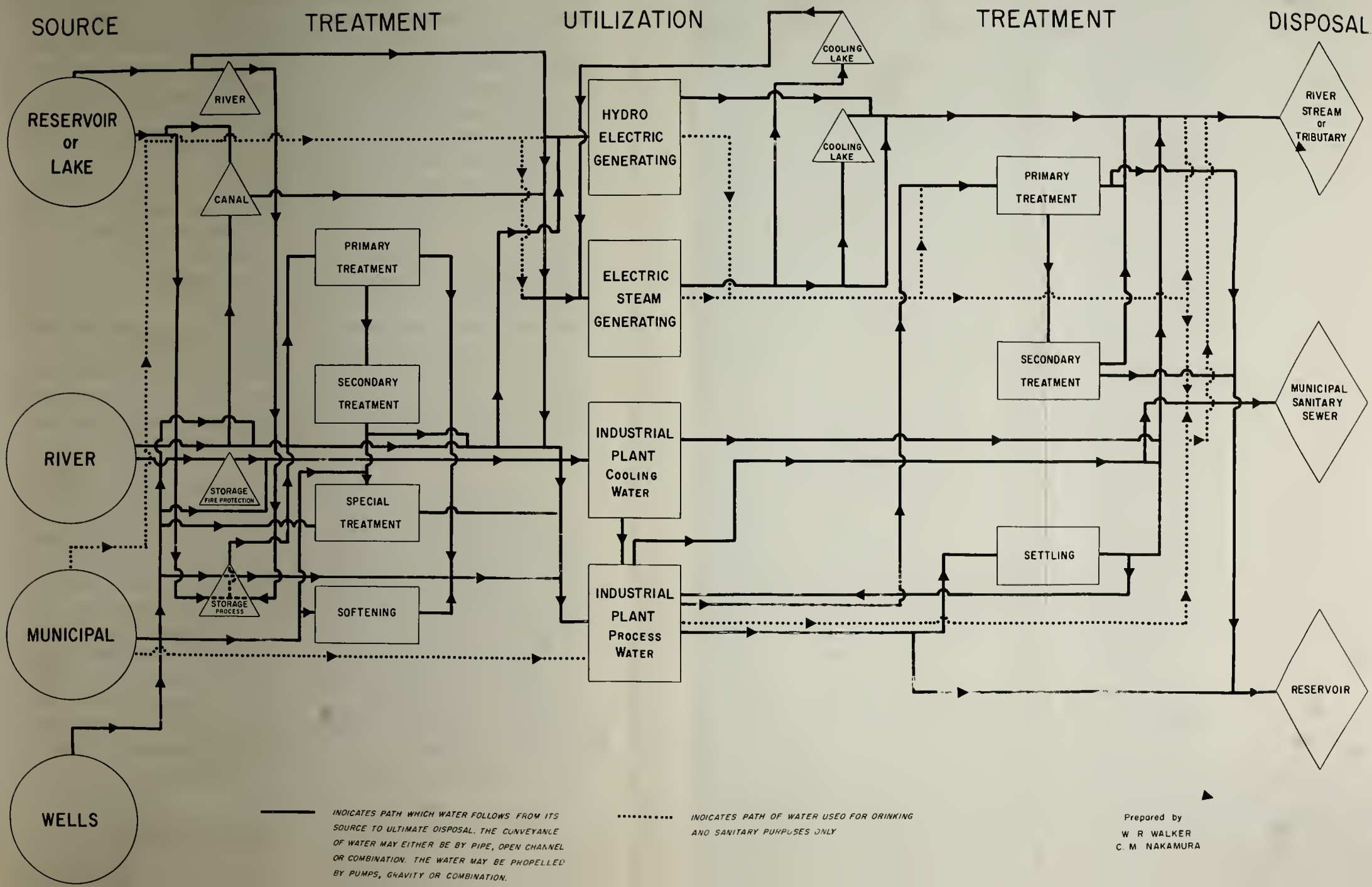
The flow chart on page 10 shows the path which industrial water follows from its source, to treatment, ultimate use, waste water treatment and final disposal. It illustrates all of the various ways of handling water which were encountered in this study. Not all water receives treatment before use (e.g., cooling water) and much of the industrial waste water was discharged into streams and reservoirs without treatment. Some waste waters were treated, circulated for re-use, and never reached the point of ultimate disposal.

Some companies obtain their process water from a private source but use municipal water for drinking and sanitary facilities. The latter is shown on the chart by a dotted line.

The media for transporting water from one point to another is not shown except in the case of cooling water where canals and small tributaries are used. Pipes are primarily used to convey water from its source to treatment facilities and point of use. In the case of waste water, open channel flow was more common although there are many examples where pipes and open channel flow are combined.

Industrial uses of water encountered in this study include manufacturing process uses, human consumption, sewage and waste dilution, hydroelectric power generation, cooling water for steam electric generation and manufacturing processes, air conditioning, washing and processing of minerals and stone, ice production, boiler water, integral part of finished product, media for transporting food products, cleaning and general hygienic needs and fire protection. This list of uses is not exhaustive but it does serve as a reminder of the versatility and importance of water to the industrial community.

FLOW CHART OF INDUSTRIAL WATER USE



Prepared by
W R WALKER
C. M NAKAMURA

Stream Sanitation Law

North Carolina, like most eastern states, continues to operate under the common law riparian rights doctrine of water law, modified only slightly by statute. Industrial water use in the State thus is not now subject to State regulation as to the quantity of water used or the circumstances of its use. The disposal of industrial waste and sewage, however, is materially affected by State regulation of water quality embodied in the State Stream Sanitation law. Before considering the findings of this report concerning the selected study industries, it will be helpful to review briefly the history of stream sanitation legislation in North Carolina.

North Carolina in the past has been fortunate in having an abundant supply of water for most uses. It was apparent from the beginning that some regulation of streams might be necessary to promote the most effective use. As the economy of the state changed, the relative importance of the various uses also changed. The present stream sanitation law has the most significant effect on industrial water use as it authorizes the classification of streams according to their best use and regulates discharges into the stream in terms of these classifications. A brief glance at the legislative history will provide the background which gave rise to this law.

The first legislation concerning the streams of the state was enacted during the early colonial assembly to encourage navigation. Later the county courts of pleas were made responsible for supervising the rivers of their counties and for seeing that all dams provided for the free passage of fish and of logs being floated to sawmills.

In 1903 the General Assembly passed Public Law 159 which required more frequent inspection of the source of public water supply and prohibited the discharge of untreated sewage into any stream used as a public drinking supply until it had passed through a sewage purification system approved by the State Board of Health. Failure to treat the sewage as required was made a misdemeanor and subject to injunction. In 1906 the Supreme Court declared the act to be constitutional and a valid exercise of the police power of the state.[4] The opinion of the

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[4] Durham v. Eno Cotton Mills, 141 N.C. 615, 54 S.E. 453 (1906).

Supreme Court stated ". . . the Legislature has decided that it is desirable to preserve our natural streams in at least their present state of purity, and, where they have been polluted, to remove the cause as speedily and effectively as possible."

In 1911 the waste disposal provisions of the public health laws were rewritten in form but were in reality a re-enactment of the acts of 1893, 1899, and 1903, with little or no revision. These acts are still in effect today and the following constitutes the most important sections:

(1) G.S. 130-109 provides that the Board of Health shall have supervision and control over all inland waters, . . . and shall make such rules and regulations as it shall deem necessary to prevent contamination and to secure other purifications as may be required to safeguard the public health.

(2) G.S. 130-110 provides that the Board of Health shall consult with and advise municipalities or corporations having or proposing a system of water supply or sewerage. . . . Municipalities are prohibited from contracting for a water or sewage disposal system until their plans are approved by the Board of Health.

(3) G.S. 130-117 provides that no person, firm, or corporation or municipality shall discharge into any stream above the intake from which a public water supply is taken unless the sewage shall have been purified by a method approved by the State Board of Health.

With the Supreme Court's approval of the "police power" several actions were brought in court to obtain damages because of property injury by streams polluted by municipal sewage. The courts consistently held that pollution and contamination of a stream such as to render it unwholesome, impure, and unfit were a nuisance. In an effort to stem the tide of civil suits many cities began purchasing easements along the banks of rivers and streams into which their municipal wastes emptied.

With the coming of the depression of the 1930's many industrial plants were closed but the pollution load was not diminished since many municipalities were not in a financial position to treat their own wastes. It was during this period that the City of Smithfield attempted to prevent the City of Raleigh from discharging its untreated waste into the Neuse River which constituted the water supply for Smithfield. The act of disposing into the Neuse River seemed to be in the very "teeth" of the General Statutes 130-117. When Raleigh ignored the State Board of Health order to desist, the City of Smithfield brought an action to enjoin Raleigh from polluting the Neuse. It is interesting to note that the trial judge refused to grant the injunction because of Raleigh's financial condition (it had defaulted twice on the repayment of bonds) and the fact that there was no evidence that the citizens of Smithfield had been injured by the action of Raleigh. On appeal the Supreme Court upheld the trial court's ruling. The Supreme Court did say, however, that this act constituted the public policy of the state and that Raleigh should not unreasonably delay in complying with it. When no action had been taken by 1948, the City of Smithfield brought another action to restrain Raleigh from dumping untreated sewage into the Neuse. The Superior Court ruled that Raleigh must install and have operational by January 1, 1956, adequate sewage treatment facilities to reduce the pollution load in the Neuse.

Prior to 1937 very little was done in the legislative arena to either enforce or re-enforce the general policy laid down. In 1937, a state planning board recommended that additional waste removal legislation be enacted and SB 180 which was designed to preserve the purity of the waters of the state was introduced but was defeated in the Senate. In 1945 enabling legislation for the establishment of a petroleum division of the Department of Conservation and Development in the event that gas or oil was discovered in the state was passed. The division was authorized to make, after hearing and notice, reasonable rules and regulations and orders as might be necessary to prevent the pollution of fresh water supply by oil, gas, or salt water. Since neither oil nor gas was discovered in the state, the petroleum division has never been activated.

A resolution, HR 1043, was introduced into the 1947 General Assembly which would require all persons, firms, or corporations discharging waste material into streams of the state to use every available means to treat the waste material so as to render it free from offensive odors and to prevent harm to fish life. This resolution directed the Department of Conservation and Development to make periodic inspections to determine whether or not all firms were taking such action and to report their findings to the General Assembly in 1949. Although the resolution passed the House, it was defeated in the Senate. In 1949, on the basis of field investigations and research by the Stream Sanitation and Conservation Committee, HB 458 was prepared and introduced to the General Assembly. The bill was similar in content to that which has been recommended and presented at the 1937 General Assembly but this bill failed to pass the second reading in the House.

In 1951, Article 21 of Chapter 143 of the General Statutes relating to stream sanitation was rewritten. In the new form the General Assembly created a State Stream Sanitation Committee with a technical staff to begin the classification of the sixteen river basins within the state. This Committee was authorized to classify the streams for their best use and gave them power to bring violators into compliance within a stated period of time.

Subsequent to the passage of the 1951 Act which created the State Stream Sanitation Committee, a series of special acts were passed concerning individual river basins. The first of these acts was in 1955 and dealt with the Haw River and its tributaries.[5] This act prohibited raw sewage, industrial waste, and other noxious and deleterious substances such as would render said waters harmful to the public health and fish life, from being discharged into the Haw River or its tributaries. The act specified an effective date and provided further that a violation thereof would constitute a misdemeanor and that each day on which any of the violations herein described continued should be deemed a separate offense. A civil action for injunction and the recovery of damages was permitted against any violator. Two similar acts were also passed during

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5Session Laws, Chapter 552 (1955).

this same legislative session with respect to the Northeast Cape Fear River and its tributaries[6] and the Tar-Pamlico River and its tributaries.[7] The last act of this kind was passed in 1957 concerning the waters of the Neuse River and its tributaries.[8] The staff of the State Stream Sanitation Committee report that no actions, either criminal or civil, have been filed pursuant to these special acts.

In 1915 the General Assembly passed the first of several statutes relating to the protection of fish life.[9] A steady stream of legislation has continued through the years, the most recent having been passed during the 1963 legislative session.[10] The original act in 1915 prohibited the discharge of poisonous substances which are inimical to the fish in the waters of the state. The act was originally intended to apply only to commercial fish but was later extended to game fish when the jurisdiction over this type of fish was given to the Fisheries Commission Board in 1917. In 1927 the Department of Conservation and Development inherited the maritime and game fish programs and a second "fish protective" anti-pollution law was passed, providing that no person, firm, or corporation shall allow substances poisonous to fish to flow into the waters which have been designated as fish producing waters. These acts specifically exempted cotton mills and there was some language indicating that municipalities might be within the scope of the exemption. No prosecution arose from these acts since the first was seriously questioned because of its blanket exemption to all firms chartered prior to the act. The concern regarding its constitutionality was shown to be well grounded when, in 1948, the Caldwell County Constable attempted to enforce the statute, charging a local mining corporation with emptying untreated residue into a stream.[11] This first test of the act, thirty-three years after passage, resulted in the Superior Court declaring it unconstitutional. The Supreme Court in upholding the lower court specifically declared that the legislature had authority to

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[6]Session Laws, Chapter 1139 (1955).

[7]Session Laws, Chapter 1014 (1955).

[8]Session Laws, Chapter 264 (1957).

[9]G.S. 113-172.

[10]G.S. 143-215.3(7).

[11]State v. Glidden, 228 N.C. 664, 46 S.E.2d 860 (1948).

eradicate and to avoid pollution in order to conserve fish life but that the blanket exemption of all corporations chartered prior to 1914 created an exemption having no relation to the evil sought to be remedied and its failure to apply to all corporations or persons similarly situated voided it. The second act was considered ineffective since it exempted the textile industry from its scope. Incentive for active prosecution under the second act was stifled by the specific exemption of the kaolin and mica industries.

The most recent legislation (1963)[12] dealing with fish life provides that whenever any person shall carelessly or unlawfully or willfully cause pollution of water as defined in Article 143 in such quantity, concentration, or manner that fish or wildlife are killed as a result thereof, the State Stream Sanitation Committee may recover in the name of the state the damages from such person. The act goes further and states that the measure of damages shall be the amount determined by the Committee and the North Carolina Wildlife Resources Commission. The damages shall be deemed to be the replacement cost thereof plus the cost of all reasonable and necessary investigation made or caused to be made by the State in connection therewith.

Food Processing Industry

This industry classification covers all types of firms handling foods--from sea food processors to those preparing broilers. In 1948 there were 706 firms employing 18,000 persons with an annual payroll of $39,000,000.[13] During the 1950's, employment in the industry increased about three times as fast as that for all other manufacturing operations.[14] Industrial growth in this area has been encouraged as vertical integration of the agricultural segment of state's economy appears to offer great potential.

Between the years of 1958 and 1962 employment in the food products industry increased from 31,500 to 36,000. During the past three years

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[12] Supra, note 10.

[13] Anon., "North Carolina Economic Summary," Blue Book of Southern Progress, 1949.

[14] Knapp, John L., North Carolina: An Economic Profile, Federal Reserve Bank of Richmond, Virginia.

the state has averaged 15 new food processing plants per year. In 1962 capital expenditures in excess of $11,000,000 were made for 52 new and expanded food processing plants. Seventeen of this number were for new installations. The composite picture as of 1962 shows a total of 960 plants and represents 12.7 per cent of the total number of manufacturing plants. These plants provide employment for 6.7 per cent of the industrial labor force and produce 9.1 per cent of the total manufactured products.[15]

The processing industry is represented in 83 counties. The density per county ranges from 2 to 48 firms. These figures are based on Employers Quarterly Report for the second quarter of 1962, which lists all firms employing four or more workers for a minimum of twenty calendar weeks. It is estimated that the firms listed in Employers Quarterly Report include 90 per cent of the total food processing group.

Water Source

Of the thirteen firms selected for study, five use wells and four use city water exclusively as their source of supply. The other four firms used municipal water and wells in combination. Two companies use wells as their primary source and municipal water for emergency and domestic purposes. The other plants use well water to the extent it is available but rely on municipal water as their principal source. Some older firms used wells originally because an adequate or dependable municipal water supply was not available when the plants were established. These companies have continued to operate wells because it represented the least costly method of providing process water. Increasing water charges have caused three of the four plants which use city water exclusively to actively consider wells for their future source of water.

Water Quantity and Quality

The volume of water used by the firms studied varied over a wide range. One company uses only 15 million gallons per year while three use in excess of a million gallons per day. Wells appear to be used at rural locations or for reasons of economy. Company officials

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[15]Anon., New and Proposed Industries--Reported for North Carolina, Division of Commerce and Industry, State of North Carolina.

generally felt that good water was important for a quality product but these considerations were not significant in selecting plant locations. Officials of small companies were of the opinion that availability of water was of even less importance since their needs could generally be supplied by most municipalities or wells.

Poultry processing uses water at the rate of seven to eight gallons for each bird dressed. One company official expressed the opinion that federal sanitation regulations in poultry processing encourage the wasteful use of water. An investigation into the operating procedures of several plants in the state indicated that those shipping in the intrastate market used only one-third as much water as those shipping interstate. A report by one independent consultant, based on a survey of one plant, indicated that bacterial counts were well within the federal health requirements when only two to three gallons of water were used per bird. The opinion on water wastage is not the unanimous feeling of all persons in the industry. Some feel that the standards imposed by federal regulations are in accordance with industry practice and that the water requirements are not excessive. This diversity of opinion would seem to indicate that regulations which indirectly influence industrial water consumption warrant regular re-evaluation as technology provides change as water costs are almost certain to increase and the availability of good quality process water is likely to become more limited in many areas.

Water Storage

Of the firms studied only 25 per cent had provision for the storage of process water but the capacity varied over a wide range--5,000 to 500,000 gallons. Water for local fire protection was even less in evidence as only one company had elevated storage. Some of the others relied on high pressure water lines from nearby cities for fire protection.

Water Costs[16]

Water costs for the finished product in this industry is quite low, ranging from 0.1 mill to 3.0 mills per pound. A limited sample of the firms studied indicates that this may lie in the neighborhood of 0.001 per cent of the total production costs.

The economy in using wells for small firms is suggested by the results of this study. For example, where a company using wells produced water for 11¢ per thousand gallons a similar company paid 35¢ per thousand gallons from a municipal source. The cost difference is even more significant with two other companies where the water cost amounted to $36 per million pound of product produced while a competitor using a municipal water source paid $300 per million pound of product produced. A trend may develop toward increasing use of well water for the food processing industry, especially those firms located in the eastern section of the state where the ground water sources appear to be ample.

Water Re-Use

The Stream Sanitation Law has caused many companies to examine their general operation procedures as they relate to water use and waste water disposal. In the past, firms have not considered waste water treatment as an item in their production costs. As a result some of the practices which have been perpetuated with respect to water are found to be wasteful as well as costly. Although water requirements for this industry as a whole are not large, some companies are making extensive efforts to maximize the re-use of water because of its significant impact on the waste water effluent. One company through "in plant" changes which includes a program for the re-use of water was able to reduce the volume of its waste water discharge so that it did not contravene stream standards and at the same time reduced production costs.

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[16]Water costs include all costs attributable to the procurement, distribution and treatment of either process water or water for domestic and sanitary purposes. It includes the investment in riparian rights, other water rights, reservoirs, dams, storage lakes, inlet structures, rights-of-way, easements, pumping stations, transmission lines, water storage facilities, treatment plant, and operating expenses (maintenance, labor, chemicals, electricity, etc.).

Waste Water

Four of the thirteen firms studied empty their industrial wastes into municipal sewers. Of those remaining nine firms all except one discharge industrial wastes without any form of treatment. Several of the municipalities which receive industrial waste do not treat it or the domestic waste from their citizenry. Most of these cities are under a mandate from the State Stream Sanitation Committee to provide treatment in the immediate future. Cost of treatment may cause more municipalities to adopt the practice of metering industrial wastes.

The waste from most of the food processing firms contains no toxic material, but a high biochemical oxygen demand. Some form of conventional treatment is necessary for wastes which are not discharged into municipal sewers. One company is currently treating its waste with newly constructed facilities at a cost of 1 mill per pound of production. Dilution water is usually not available in sufficient quantity to assist in waste assimilation as most plants are located on small streams with low flows.

Selected Segments of the Food Processing Industry

The growth of the pickle industry in recent years reflects the emphases being placed on the processing of locally grown agricultural products within the state. North Carolina is currently the second largest pickle producer in the United States.

The waste from the pickle industry is characterized by high solids content, low pH, high cholride content and high BOD. Biological treatment appears to provide a satisfactory method for treating all but the high chloride content of the waste. At present the companies have not found an economical method of removing the salt from the waste.

The pickle industry is concentrated largely in four companies, three of which have joined in a cooperative study of methods for reducing stream damage resulting from their industrial waste discharge. In-plant changes, various treatment processes and the moving of plants to tidal waters are all being given serious consideration and pilot plant operations are evolving from those which show the most promise.

The dressing of poultry has increased at a rate such that North Carolina is the fourth largest among the states. The classification of streams has now caused another cost factor to be injected into this

very competitive business. The waste from these plants can be satisfactorily treated by trickling filters or activated sludge process but these have received little attention in the industry because of the relatively high construction costs and exacting operation requirements. Many of the municipalities treating wastes from these processing plants require some form of pretreatment. At the other extreme, one large processor is producing a feather meal which is very high in protein content from chicken offal and feathers. The company official indicates that under some market conditions the production of this by-product is the only profitable aspect of his intergrated operation.

Water Rights

Officials from the food processing industry which were interviewed expressed no real concern regarding water rights. Their attitude is probably representative of the whole industry since these firms were large water users. Officials for companies which obtained their water from wells or a municipal source felt their water supply secure for one or more of the following reasons:

(1) The plant is situated in an isolated or rural location not likely to attract industries with a large water need;
(2) The cities which provide water have guaranteed water in an amount sufficient to meet any anticipated expansion;
(3) Test wells indicate that there is sufficient water available with the drilling of additional wells;
(4) The plant has not experienced a water shortage even during drought years.

In general the low water requirement for the food processing industry makes extremely unlikely the probability of litigation regarding water rights. To date none have had difficulty with waste water disposal except for chemical "spills." One firm was involved in a "fish kill" but escaped liability under the Stream Sanitation Law because the stream which received the chemical had not been classified for a period of 60 days prior to the spill.

Paper and Pulp Industry

North Carolina's paper and pulp industry is concentrated primarily in seven companies. Three of these are located in western Carolina on tributaries of major rivers, and the others are on the large rivers in

eastern Carolina. The largest and oldest paper plant started operating in the state in 1906 and the latest paper company to locate in North Carolina did so in 1951.

Two of the older firms were originally established for the purpose of extracting materials from hardwood trees for use in the tanning industry. Crushed pulp was the waste product from this operation and efforts to profitably utilize it led the companies into the production of paper. In the last ten years the making of extracts from woods has been completely discontinued since they can be produced more cheaply by synthetic methods.

The companies which are located in the eastern section of the state were established later in time and are located on major rivers. These plants were built exclusively for the production of paper and pulp and their site selection reflects concern for the availability of water as well as the basic raw material, timber.

Water Source

The water required for the paper and pulp industry is usually of such magnitude that its source is either a large river or reservoir. There are a few examples in other states where ground water sources are adequate. Most cities do not have a sufficient capacity to provide these operations with water even if it could be done economically. The seven plants in North Carolina use water exclusively from rivers. One company takes water from a tributary but maintains an auxiliary line to a major river for emergency supply. Of the other two firms located on tributaries one uses almost the entire average flow while the other uses 10 to 20 per cent of the average flow. Two companies maintain water lines to municipalities for drinking water and sanitary facilities.

Water Quantity

The companies have a combined water use of 172 million gallons per day. One plant uses as much as 45 million gallons per day and each of five plants uses in excess of 20 million gallons per day.[17]

Many of the officials interviewed stressed the re-use of water by their companies to assure an adequate supply and to maintain the cost

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[17]Water quantities reported in this study represent the best estimates of the company officials interviewed and are not to be considered metered quantities.

of water at the lowest possible level. During the past five years one firm, through the skillful re-use of water, has not increased its consumption of water while production has increased threefold. On an average, this firm uses all water approximately five times before returning it to the river. Usually water is first used for cooling and then for process water. Plants located on rivers with large flow sometimes use raw water for cooling and return it directly to the river untreated. Most of the firms, however, treat a substantial quantity of their water to some degree.

Riparian Rights

The extent of riparian ownership varies considerably with the company involved. Those companies located on smaller streams with a limited water supply have a substantially greater investment in land along the stream bed. Two companies own land on both sides of a river over its entire length with the exception of federal lands. Firms located on rivers with a large flow, however, own only such property as is necessary from an operational standpoint. Riparian rights strictly speaking are not considered significant and in some situations the river frontage may be as little as 1,000 feet.

Water Cost

The cost of water per ton of production varies from a few cents to several dollars per ton. The highest cost is several hundred times that of the lowest. This large difference in cost is due to the extreme contrast in the two paper making activities. In reality they are not truly comparable activities except that the finished product of both is paper. The factors which contribute to variations in cost are:

(1) raw material (reclaimed paper or wood)

(2) quantity of water required (very little or substantial quantity)

(3) quality of water (no treatment or high degree of treatment)

(4) land holdings and physical appurtenances necessary to secure a water supply (practically no investment or very high investment in water rights, auxiliary water supply, reservoirs, tanks, pumping and treatment facilities).

The water cost for the other firms is grouped more closely between these two extremes, ranging from 25 cents to a dollar per ton of paper.

Storage

Small lakes or concrete tanks are often used for storage to insure a continuous supply of water for production. One of the more unusual situations involves the use of an old power canal as a reservoir. The largest raw water storage, 670 million gallons, is provided by a 45-foot dam on one of the small tributaries. Elevated storage is provided at most plants for fire emergencies.

Water Treatment

All of the firms studied except one maintain complete treatment facilities, although the exact method of treatment does not appear to follow a uniform pattern. The physical layout of the plant, water source, and finished product are some of the factors accounting for the variations in treatment facilities.

Waste Water Treatment

Finding economical methods for treating their industrial wastes is one of the biggest problems confronting the paper and pulp industry. It is the opinion of some company officials that increased production and future plant expansion will not be hampered for lack of process water but will be limited by the availability of water to assimilate waste without expensive treatment processes. Prior to the passage of the Stream Sanitation Act,[18] wastes were discharged into rivers and streams without any treatment. With one exception, all plants are now confronted with a need to treat their industrial waste to meet the classification of the receiving stream. This means capital expenditures and annual operating costs without any increase in production. One company, by regulating the rate of discharge, disposes of its waste directly into the river without treatment. It may however, have to lagoon some wastes to avoid the contravention of stream standards during periods of low flow. The majority of firms operate under a temporary permit from the State Stream Sanitation Committee, which requires that their waste effluent not contravene stream standards at the expiration of the permit. To date these permits have not exceeded five years in duration but there have been instances where the permits have been extended.

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[18]G. S. Article 21, Chapter 143.

Most companies are engaged in some form of pilot studies in an effort to find the least costly means for treating their wastes. Studies by several companies indicate that the cost of waste treatment may range from 90 cents to eight or nine dollars per ton of paper. One company official stated that, unless waste water can be treated for a cost of three to five dollars per ton of paper, their plant could not remain competitive at current market prices. Another official indicated that the margin of profit in the European market in many years may well equal or exceed the estimated cost of treating the industrial waste.

One of the more interesting methods being explored involves the concentration of the waste materials for burning. The company is attempting to use screw presses to concentrate its "black liquors." The screw press method has been used successfully under production conditions as a single unit but the required concentrations for burning necessitates that they be operated in series. More tests are to be run to determine whether the presses in series will increase production time or create a quality control problem.

Litigation

None of the officials contacted could recall their company being actively involved in water rights litigation. A possible explanation is that the older firms located on streams when there were few other users and other large users have been reluctant to locate in the immediate area in competition with their use. Firms which have located in the state in later years have selected sites which tend to minimize the possibility of water rights litigation.

All litigation or potential litigation concerning water reported by company officials has been with regard to the disposal of industrial waste water. One company recently had a chemical "spill" which resulted in a fish kill. It is now involved in litigation with agencies of the State. Other firms indicate that they have had fish kills in the past but these incidents have never reached the point of litigation. In one situation, a commercial fishery downstream was bought out in an effort to avoid litigation. This situation may change with the passage of the 1963 amendment to the Stream Sanitation Law which imposes liability on the part of persons responsible for fish kill. The substance of the amendment

provides that the Stream Sanitation Committee shall have the authority to investigate any killing of fish and wildlife which in their opinion resulted from the pollution of waters and to recover damages from the person responsible in the name of the state. The measure of damages is to be the replacement cost of the fish or wildlife destroyed plus the cost of all reasonable and necessary investigations made or caused to be made by the State in connection therewith.

Industrial Metering and Testing

In an effort to more accurately predict the flow of the two branches of the Pigeon River at various sections, Champion Paper Company installed automatic gauging stations which record at the plant hourly by teletype. The gauging stations were installed by the company but are now operated by TVA. Information from these stations enables the company to regulate the water discharge from its dam to insure a constant supply for production without wasting water.

Readings can be obtained from these stations at any time by use of a telephone code. The availability of instantaneous readings is valuable in predicting flood stages in the river. The Pigeon River has had variation in flow from 26 million gallons per day to 4 billion gallons per day. With these stations the plant has a minimum of three hours warning in case of flood, enabling them to activate flood control measures.

The testing program initiated by Albemarle Paper Manufacturing Company is an example of the extent to which industries have had to enter into the field of stream sampling and testing to help resolve problems related to industrial waste disposal. To determine the effect of the industrial waste discharge on the receiving stream the company now makes daily determinations for dissolved oxygen, pH, alkalinity, sulfides and BOD at significant points in the stream from the mill to the low point in the oxygen sag curve 35 miles downstream. (In addition dissolved oxygen determinations are made above the mill and for water released from the Roanoke Rapids Dam.) Automatic recording of the flow in the river enables the company to adjust its waste discharge to the assimilation capacity of the stream.

Other companies are doing limited and intermittent type gauging and testing but the above two examples indicate the extent to which it has progressed. The trend will probably be more intensive testing by all

industries with manufacturing processes which are dependent on large volumes of water for both supply and waste disposal.

Textile Industry

The leading manufacturing activity in the state is textile production. In terms of value added,[19] textile firms make almost a fourth of all the woven cotton goods in America and more than a third of the man-made fiber fabric. Nearly one-fifth of the nation's textile employees work in North Carolina plants. In 1960, the textile industry accounted for 44 per cent of the state's manufacturing employment and 33 per cent of the value added.[20]

The textile industry has a long and continuous history in North Carolina. The oldest company visited was founded in 1877, while one of the more recent textile firms to locate in the state did so during the 1950's. Plants are found in 78 of the 100 counties but the majority are located within forty miles of Interstate 85, an east-west highway through the state.

This study is limited to the part of the industry concerned with finishing and dyeing. It is this part of the manufacturing activity which has the large water requirements and the waste with the deleterious effect on the receiving stream. Twenty-two textile companies including Burlington Industries, Inc., Cone Mills, Inc., and Fieldcrest Mills, Inc., were contacted during this survey. The above mentioned manufacturers all have several plant locations within the state using water in sufficient quantity or with an industrial waste of significant magnitude to be included in this report as separate entries.

Water Source

The water necessary for finishing and dyeing is less than for the manufacture of paper, but is of sufficient quantity that the majority of the companies use an independent water source. One firm, however,

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[19]One of the best measures of manufacturing activity is the amount of "value added" by production. Value added is computed by subtracting the cost of materials, supplies, and power from the value of shipments. Value added thereby avoids the duplication in the value of shipment figure which results from the use of products of some firms as materials by others. Consequently, value added is a more accurate measure for comparing the relative economic importance of manufacturing among industries.

[20]Knapp, John L., op. cit., p. 20.

purchases in excess of a million gallons per day but it is only one of three companies which use municipal water out of the twenty-two companies surveyed. The water requirements for firms using private wells range from 0.3 to 0.5 million gallons per day. In the two situations where wells are the primary source of water, one company maintains a municipal connection for emergency use while the other supplements its supply with a tank truck. The latter firm is two and one half miles from a municipal distribution system but has elected, for reasons of economy, to use the tank truck rather than make the necessary connection. The remaining companies obtain water from rivers with large flows or from reservoirs on small drainage basins.

Eight of the twenty-two companies go to a municipal source for drinking water and water for sanitary facilities. In many situations companies prefer to pay a premium for drinking water rather than assume the responsibility for drinking water standards although the water used for textile finishing and dyeing may in some cases be of higher quality than is required to meet U.S. Public Health Service Drinking Water Standards. Industrial tolerances with respect to mineral content and hardness, are often more stringent than the requirements for human consumption; yet only half of the companies with extremely high water quality standards elect to provide water for domestic consumption.

Water Quantity

The water requirements reported by the companies studied range from 0.5 to 27 million gallons per day. Twelve firms use from 1 to 3.5 million gallons per day, seven use 0.5 to 1.0 million gallons per day, and three use less than 0.5 million gallons per day.

Water Quality

Thirteen firms give some form of treatment to their process water, ranging from a small amount of chemical treatment to complete treatment. Some textile processes require very soft water, down to a hardness of one or two parts per million, which necessitates treatment over and above that provided by a municipality. Some firms with sensitive processes have constructed filters with special paper media to bring the purity of the water to a very high level.

Storage

Generally, storage is not provided until the water consumption of a plant approaches a million gallons per day. The largest storage facility encountered is a lake which has a capacity of 1,350,000,000 gallons. Fewer than 50 per cent of the firms studied have elevated storage for fire protection purposes.

Water Costs

Several firms express their cost of water as a per cent of production. This ranges from a low of 0.007 per cent to 1.0 per cent of the total production cost. In cases where water costs were obtained in terms of production, they range from about 0.4 mill to 5 mills per pound of production. Although most firms do not have a direct comparison between cost of water from two sources, the few companies which use wells and municipal water, for either process or domestic consumption, find the latter to be as much as 20 times more costly than the ground water source.

Waste Water Treatment

Firms which located in North Carolina subsequent to 1951 are practically the only ones which have operating waste treatment facilities. The older firms are in the process of building treatment facilities, making engineering studies or operating pilot plants. Of the firms already treating their waste, the majority are using aerated lagoons and one is having satisfactory results with an activated sludge plant. The cost of treatment and disposal for a limited sample ranges from 0.4 mill to 3.3 mills per pound of production.

In situations where both a municipality and an industry are directed to treat their wastes by the State Stream Sanitation Committee, many companies elect to treat their own waste rather than enter into an agreement whereby joint treatment facilities are constructed. Exceptions arise where a company is the largest single taxpayer in a municipality. Under these circumstances a company may find substantial economy in a larger single plant capable of treating both wastes rather than pay for two smaller facilities, one to treat its waste and the other to treat municipal waste.

Co-operation between municipalities and industries is encouraged when the industry is extremely large in relation to the local municipality. In North Carolina this has taken the following forms: (1) industry builds a treatment plant and treats the domestic sewage of the

municipality; (2) industry makes a substantial contribution to the building of a plant and agrees to contribute to the annual operating cost of the plant on some formula related to services rendered; or (3) industry buys the bonds to finance a plant large enough to treat the industrial waste.

Riparian Rights

The position of individual firms with respect to water rights depends on the company's water requirements and the source of water. The large water users on relatively small streams have purchased extensive riparian rights to insure so far as possible their right to use the entire flow from a tributary. These firms also have developed secondary sources of water which may be in the form of dams on other tributaries with pipelines to the main reservoir and/or connections to municipal sources. Those which have a large water requirement and are using ground water sources likewise have increased their surface holdings to minimize the possibility of others using their aquifer. Companies located on large streams feel they have no water problems and many small firms have elected to handle critical water situations when they develop.

Litigation

Most officials interviewed indicate their companies have not been actively involved in litigation concerning water rights but some have had litigation with respect to waste water discharges. One case involved a fish kill and another was concerned with the death of cattle owned by a downstream farmer.

Electric Operating Companies

Three major private utilities--Carolina Power and Light Company, Duke Power Company, and Virginia Electric Power Company--serve most of North Carolina. Nantahala Power and Light Company, a complete hydroelectric system is a small private utility which services five counties in the southwestern section of the state. TVA has several hydroelectric generating facilities in this section of the state, but no distribution system.

Carolina Power and Light Company has five major steam generating plants and one minor steam plant plus three major and two minor hydroelectric plants; Duke Power Company has seven steam plants plus

thirty-two hydroelectric plants; and Virginia Electric Power Company has two hydroelectric plants in the state. The proportion of hydroelectric to steam capacity is approximately the same for all three companies, ranging from 12 to 18 per cent. Alcoa through its subsidiary, Yadkin, Inc., has four hydroelectric plants in the state which generate electricity exclusively for its aluminum plant. The present expansion of the aluminum producing facilities may increase the electric requirements beyond the capacity of the present generating units but no further hydroelectric installations are planned by the company.

Steam Plants

Steam electric generating plants require large quantities of water for the cooling of their condensers. Their water cooling facilities usually take one of two forms in North Carolina. The first diverts water from a river through the condensers of the plant into a canal leading to a cooling lake from which the water returns to the river. This arrangement may be utilized in two situations: one where the temperature rise of the discharge water from the condensers may be sufficiently high to cause damage to fish; the other where the average flow in the river is not sufficient for the cooling of the condensers and some water must be recirculated. The other method of cooling takes water from a river and directs it through the condensers, discharging it back into the river below a small dam. The dam does not seriously impede the flow of the river but merely assists in diverting the water into the condensers and prevents the mixing of heated discharge waters with the cooler intake waters. The temperature of the water being discharged in most cases does not cause a temperature rise of more than sixteen degrees. The cost of cooling water for steam generating facilities, according to reporting utilities officials, usually does not exceed more than one or two per cent of the total cost of producing a kilowatt hour of energy. Although none of the companies which serve North Carolina anticipate voluntarily using cooling towers in the future, they estimated that the use of cooling towers may increase production cost by 1/4 of a mill per KWH. (In terms of capital cost, the additional cost of cooling towers is frequently estimated at 5 dollars per KW higher than a similar plant using river water.[21]

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[21]Federal Power Commission, "National Power Survey." Advisory Committee Report #7 on Conventional Steam Generating Stations, p. 15. (1963).

Reservoir Land

The policy of the companies studied is to own their reservoir sites in fee. This includes all the lands which would be inundated when the water is at spillway height. These companies also follow the general practice of acquiring flood rights or riparian lands for a vertical distance of five to ten feet above the spillway. The exact height is usually based on the maximum flood with a frequency of once in 100 to 200 years. Further ramifications of reservoir land ownership policies will be discussed in a later paper in this series concerning water recreation.

Several companies with substantial land holdings in their reservoir sites operate forestry programs on unused land adjoining the reservoir site to assist in erosion control and to provide a return on the investment in extra land. Most of the extra land is acquired when the company purchased an entire operating unit but needed only a portion of it for the reservoir site.

Dam Operations

Firms with hydroelectric facilities in series follow a systematic practice of drawing down their reservoirs during certain periods of the year, to permit them to fill during the rainy season. The loss in generating efficiency from the lower operating heads is apparently much smaller than the economic loss sustained by having to waste water over spillways during the period of heavier rains.

Litigation

Very few of the firms studied report active litigation with respect to water rights. Most litigation has been confined to condemnation proceedings in the acquisition of property for hydroelectric sites and reservoirs. Carolina Power and Light Company has, however, been a party to several cases resulting from damage allegedly caused by the operation of a hydroelectric dam.[22] One of these reported decisions, the Dunlap case, contains a comprehensive statement of the doctrine of riparian rights as applied in North Carolina.

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[22]Bruton v. Carolina Power and Light, 217 N.C. 1 and Dunlap v. Carolina Power and Light Company, 212 N.C. 814.

Reservoir Water Use

A minimum of sixteen towns and two industries obtain water directly from electric generating storage reservoirs. The policy of these companies with respect to the use of water from reservoirs by municipalities and industries varies. One company permits cities and industries to take as much water as they desire from the reservoirs provided they agree to assume their proportionate share of any liability which may arise from the diversion. One company allows only a stipulated amount to be withdrawn from a lake; another restricts water use to those whose water supplies have been destroyed or impaired through the construction of the reservoir. Another permits water to be diverted from its reservoir provided treated effluent is returned to the lake. The number of industries served indirectly from storage reservoirs is quite large. Charlotte, the largest city in the state, uses a reservoir as its principal source of supply.

The practice of taking water from reservoirs under circumstances where there is no obligation to return it may present future problems for cities or industries which discharge their waste water into another river basin. These situations are not likely to become important until an extended drought period occurs.

Reservoir--Recreation

The strong interest in outdoor recreation by the general public is emphasized by the fact that all of the power generating companies permit their reservoirs to be used for fishing, boating, and swimming. One company, at considerable expense, actively promotes and encourages the use of its reservoirs for recreation by financing and building facilities for the use and enjoyment of the general public. Other companies prefer to make their facilities available through the North Carolina Wildlife Resources Commission. In these situations they lease the property at a nominal rate to the Commission for use and development. Under these circumstances regulation and control of the recreational activities are under the supervision of a public agency.

Both industrial and municipal pollution have affected the recreational use of some lakes. For example, the Pollution Survey Report for the Yadkin River Basin published in 1953,[23] indicates there was evidence

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[23] Yadkin River Basin - Pollution Survey Report No. 1 (1953).

that industrial wastes from Buck Steam Electric Power Plant and North Carolina Finishing Company and municipal pollution from Lexington, Salisbury, and Spencer were affecting recreational uses of High Rock Lake.

Water recreation is also affected by routine power reservoir operations which cause lake level fluctuations and other problems for recreationists. This subject will be considered at greater length in a subsequent publication in this series on water recreation.

Industrial Growth

The industrial growth of the state has caused the demand for electricity to double approximately every ten years. In recent years the major utilities have increased their capacity at a rate which doubles their size every seven to eight years. Additional generating facilities will enlarge the demand for cooling water which may increase the number and size of impoundments as well as the possibility of thermal pollution.

Pump-Storage Sites

In North Carolina only TVA with its dam on the Hiwassee River utilizes pump-storage facilities for the generation of electricity. This method of generating electricity has been quite widely used and accepted in neighboring states but it has not yet become necessary in this state because conventional hydroelectric sites can be economically developed. Some company officials feel that if the price for uranium should drop to a level which would make the use of nuclear power as a primary generating source less costly than steam generation, pump-storage sites might provide a less costly method of meeting peak power demands than conventional hydroelectric facilities. In any event, whether it comes about as a result of changes in competitive fuel costs or of other causes, it is not unlikely that pumped storage generation will eventually become more prevalent in North Carolina.

Federal Power Commission Licensing

Most hydroelectric projects which generate power for sale to others operate under Federal Power Commission licenses. The only known exception is Nantahala Power and Light Company, which has none of its generating facilities under license. The present Federal Power Commission appears to be making a concerted effort to license all existing electric generating facilities.

Stream Flow and Water Quality

A growing need of industrial plants located downstream from hydroelectric dams is for regulated stream flows with sufficient dissolved oxygen content to assist in the assimilation of wastes having a high BOD. Plants attempting to control their waste discharges according to the flow in a stream cannot do so with any degree of confidence without expensive storage facilities. The amount, the rate, and the quality of streamflow are all important to these companies.

Upstream hydroelectric dams may adversely affect the downstream industries in any of several ways. The construction of a dam and storage reservoir may result in stratification of the impounded waters, and the several strata may vary considerably in dissolved oxygen content, temperature, etc. If the turbine intakes are so located in the dam as to tap water of low quality the downstream flows will be adversely affected. One solution is indicated in a recent licensing action of the Federal Power Commission affecting a North Carolina project. To improve the quality of water released from storage at Vepco's Gaston and Roanoke River projects, the Commission prescribed a minimum DO content for waters being discharged from the turbines. This resulted in Vepco building submerged weirs at a cost of $850,000 to skim off the better quality water near the reservoir surface.[24] Perhaps prompted by this experience Duke Power Company installed similar facilities costing $235,000 at its Cowans Ford Development without such license conditions.[25] The temperature of water releases can be affected by varying the locations of turbine intakes, and this too might be brought about by FPC license conditions.[26]

Industrial firms can hardly take it for granted that power companies will always voluntarily install such facilities as the magnitude of these investments for improved water quality are quite large. Where projects are subject to FPC licensing the needed stimulus may come from the FPC itself. This Commission, however, does not have the staff to search out

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[24]Virginia Electric Power Company, Project Nos. 2093 and 2009, 23 FPC 337 (1960).

[25]Duke Power Company, Project No. 2232, 23 FPC 554 (1960).

[26]See Turlock Irrigation District and Modesto Irrigation District, Project No. 2299. Examiner's Initial Decision, June 4, 1963, p. 43.

all ramifications of proposed projects, and the initiative for unique water conservation requirements will more often rest with affected state and private interests. An example in point is the Gaston project where the moving force behind the license conditions was a confederation of state and local interests that reviewed the water quality needs and made a strong case for their recommendations to the FPC. Similarly, on the Cowans Ford project the encouragement of the N. C. Stream Sanitation Committee played an important part in the installation of the weir.[27] Where hydroelectric projects are not subject to FPC licensing jurisdiction, as with Corps of Engineers dams, it may be necessary for the affected industries to make their case before a Congressional Committee or some other forum.

Another problem for the downstream industry arises from the nature of today's electric system operations. A hydroelectric plant at a storage reservoir when operated as part of a unified steam and hydro system is ordinarily most valuable as a peaking plant. It is usually much cheaper to run the steam plants for baseloads and the hydro plants to meet peak demands. When this is done, water is usually stored at the hydro project with little or no release during off-peak periods and released to meet peak power requirements. Obviously this type of operation unless modified will result in erratic downstream flows.

Here again, the Federal Power Commission has sometimes accommodated the needs of downstream water users by prescribing license conditions that insure regulated flows. In some cases the Commission has required the installation of regulating reservoirs downstream from the hydroelectric installation to even out the flows or has required a licensee to operate its project to partially reregulate flows from an upstream dam. In other cases the Commission has prescribed minimum flow requirements either on a daily basis or a continuous flow basis. An average daily flow requirement might provide less benefit for downstream users

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[27]See generally, Milton S. Heath, Jr., "Some Legal Aspects of Federal and State Regulation of Water Pollution." Paper presented at 13th So. Munic. & Ind. Waste Conference, Durham, N. C., April 16, 1964.

than a continuous flow condition.[28]

It should not be inferred from this discussion that all hydroelectric projects pose the same problems for downstream water users. For example, the effect on streamflow of a "run-of-river" plant with very limited storage capacity may be negligible. In any event, it will ordinarily affect streamflows to a lesser extent than a major storage reservoir.

In recent years there have been several reported cases of "fish kills" which have been attributed to thermal pollution from steam generating facilities. In recognition of this problem some of the recent plant expansions include cooling lakes where none were provided at the time of the original installation. The State Stream Sanitation Committee is now conducting a joint study with Carolina Power and Light Company on cooling water temperatures. The tests being run are expected to be complete by the end of 1964, and the results will probably form the basis for cooling water regulations to be issued by the committee.

Problems of Upstream Industries

A hydroelectric project may also complicate the waste disposal problems of an industry located on or above the project by changing a flowing stream into a still reservoir. A dam in Georgia was reported to have decreased the assimilation capacity of a free flowing river by eighty per cent.[29] The possible effects on an upstream paper and pulp mill site have been injected into hearings on a proposed Corps of Engineers project in South Carolina.[30]

To date this problem has not fully presented itself in North Carolina. However, one textile plant may be required to treat its wastes to a much higher degree because of decreased assimilation capacity caused by a reservoir.

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[28]For a review of these license conditions see "Relation of Activities of the Federal Power Commission to Problems of Water Pollution Control." Statement by Joseph C. Swidler, Chairman of the Federal Power Commission before the National Resources and Power Subcommittee of the House Committee on Government Operations. June 14, 1963.

[29]Krenkel, Peter A., Report for Georgia Kraft Company on Coosa River.

[30]Hearings before Subcommittee on Flood Control of the House Committee on Public Works on Trotters Shoals. 88th Cong., 1st Session, April 1963.

Private Industrial Electric Generating Facilities

The State Stream Sanitation Committee Reports[31] on the sixteen river basins in North Carolina list fifteen industrial firms which generated electric power. A survey concerning the operation of these facilities was made by mail and eleven companies, representing ninety-one per cent of the generating capacity, responded.

Ten of the eleven firms use hydroelectric generating equipment but none operates under an FPC license. One firm indicated, however, that it reported annually to the Federal Power Commission on power generating facilities.

The capacity of the plants ranges from 187 to 9,800 kilowatts, the average being 1,285 kilowatts. The generating facilities produce from fifteen to seventy-five per cent of the companies' power requirements. All of the companies responding, indicated they do not plan to expand their generating capacity and two anticipate discontinuing power generation within the next several years.

Of the ten firms using water as their prime source of power, three obtain their water through canals; the remaining seven generate directly from a river. Where canals are used, ownership is excluslve in the companies using them. Most of the companies own in fee lands which are to be inundated when the river water reaches dam height. Only one firm generating directly from a river had acquired additional water rights. The majority of the companies rely on those rights which accrue to them by virtue of being riparian owners. In some cases, however, the companies have increased their riparian ownership by buying additional land both above and below their dam sites. The largest river frontage purchased by any one company extends a distance of two miles above and below the generating structure.

None of the firms evidenced any involvement in litigation concerning water rights. One firm indicates, however, that from time to time in the past, they have purchased or secured water rights above their dam.

Most of the reservoirs are also used as a source of process water. The use of this water ranges from 10,000 to 500,000 gallons per day. One

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[31] Supra, note 2.

steam plant with a 3.5 million gallon reservoir for cooling water, permits it to be used as a source of water for a municipality. Five of the reservoirs are being used for fishing, boating, and swimming or some combination thereof. The companies attempt to exercise very little control over this type of activity, and their unofficial policy appears to be neither to encourage nor discourage the use of the reservoirs for recreational purposes.

The trend appears to be toward a decreasing number of the private generating facilities; however, it is extremely unlikely that they will all be eliminated in the foreseeable future.

Municipal Electric Generating Facilities

Greenville, Rocky Mount, Kinston, and Wilson are the only North Carolina municipalities which operate electric generating facilities as part of their municipal function, and all of these are steam electric plants. The combined generating capacities of these municipalities are approximately 85,000 kilowatts which represents twenty-five per cent of the power needs for their distribution systems. None of the cities plan to expand their facilities and one contemplates discontinuing power generation in the next few years.

Three cities take cooling water from rivers, pass it through condensers, and discharge it back into the various rivers a few yards below the intake structures. During past periods of low flow there has always been sufficient water in the rivers to permit efficient operation of the condensers. The officials interviewed reported that the temperature rise in the water has not been sufficient to date to constitute thermal contamination. The cities do not own riparian rights beyond those which accrue to them by the ownership of land for the power station. The cost of cooling water for cities using river water rarely exceeds 0.2 mill per KWH.[32] The city of Wilson uses municipal water for cooling: therefore electric generating costs are higher. Recirculation of water through cooling towers keeps their water requirements to a minimum.

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[32]This includes the cost of intake and exit structures, pumps and stand-by equipment and annual pumping charges.

Electrical Equipment

The manufacture of electrical components and equipment is a segment of North Carolina's industry which has experienced very rapid growth in the past fifteen years. The electrical machinery industry has increased its employment from less than 0.1 per cent of all manufacturing employment in 1950 to 5.0 per cent in 1961, and is now the seventh largest industrial employer in the state. In 1962 it was the fifth ranked industry in the state for "value added"[33] by production, being 6.2 per cent of the total. During the period from 1960 to 1962 an average of six new electrical equipment companies per year commenced operations in the state and ten firms per year expanded their production facilities.

Water Source

Only two firms in this classification were studied. The State Stream Sanitation Committee survey of river basins lists one firm as using in excess of 100,000 gallons of water per day from a ground water source and one firm with a waste which contravenes stream standards.

A ground water source was selected by the first company because of the treatment to be given the water and amount required. The management of the company had serious reservation as to whether chlorinated municipal water could be de-ionized economically. Wells also represented the most economical source for cooling water. The quantity of cooling was quite large since the complete manufacturing area was air conditioned. A connection to the city's distribution system was established for water used for drinking and sanitary purposes since the original tests of the well water did not meet state drinking water standards.

The other firm uses a municipal source for both drinking and process water because of the attractive water rate. It is prepared to go to ground water or surface water sources whenever it is less costly to do so. The cost of water for both firms ranges from 0.5 to 2.0 per cent of the total production cost.

Water Quantity

The amount of water used varies between 0.75 and 1.25 million gallons per day. A cooling tower and pond is used by the firm which air conditions

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[33] Supra, note 19.

its plant in order to conserve water.

Water requirements are higher than might be expected for this industry. In one case water is needed for the cooling of furnaces and in the other for a controlled environment.[34]

Industrial Waste

Substantial industrial waste problems are not generally associated with this type of operation but in the case of one company the cooling water did not dilute the untreated domestic sewage and process water sufficiently to avoid lowering the quality of the receiving stream. The State Stream Sanitation Committee recommended that the domestic waste be separated from the cooling water and treated by the company or the adjoining municipality.

Quarry Operations

The quarries in the state, which use large quantities of water for the washing and processing of material, are operated primarily by three major companies. Superior Stone Company, with twenty plants throughout the state, is devoted primarily to the production of crushed stone. Becker County Sand and Gravel Company since 1955, has been the largest producer of sand and gravel in the state. Since World War II the largest known lithium deposit in the United States has been operated by Foote Mineral Company at Kings Mountain.

Water Source

The production of sand, gravel, and crushed stone as well as some other minerals requires large quantities of wash water in the production of the finished product. The economics of production make it necessary that the material be processed at the quarry site. Most of these deposits are located on small tributaries which provide water in varying amounts for the washing operation. The companies rely on their rights as riparian owners to use the waters of such streams. In some states where the water table is extremely high, well water can be used economically. Although some sections of North Carolina have an abundant supply of ground water, in most situations it is not close enough to the surface to permit this type of operation.

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[34]This is the only plant visited where the entire manufacturing facilities were air conditioned. Most companies air conditioned only the office areas.

Water Quantity

The amount of water required to process gravel and stone is almost a direct function of the plant's production--double production, double water consumption. Plants in the state use from 0.5 to 3.0 million gallons of water per day, at a cost rarely exceeding one cent per ton of production.

Water Storage

Since the source of water for many quarry operations is a small stream, water storage and the re-use of water are essential in most situations. Many plants endeavor to establish ground water storage in sections of the quarry which have been previously worked. In some cases plants maintain a 24-hour pumping operation from the streams to the storage reservoir where the material is washed. During periods of low flow and high production, wash water which is improperly treated is sometimes re-used with some sacrifice to the quality of the finished products. One company by means of coagulants successfully re-uses all its water with no sacrifice in quality.

Wash Water Treatment

The classification of streams in the state has imposed on this industry the requirement of removing large quantities of settleable solids from wash water. Most firms attempt to use a section of the quarry which has been worked as a settling basin before routing the effluent into the receiving stream. In the past the detention time in these settling basins has been determined by the ease with which an area could be converted into a holding pond. In the future the size may be dictated by the quality of the effluent to be discharged.

Miscellaneous

Some individual companies which have no other counterpart in North Carolina were included in the study. An investigation of these firms disclosed the only example where an upstream industry had co-operated with a downstream company to minimize the effect of the waste discharged upstream. In this situation the two companies jointly financed a canal which carried the upstream waste past the water intake of the downstream user, thus reducing substantially the treatment problems of the downstream user.

Water for Drinking and Sanitary Facilities

Regardless of the sources of process water, industries follow a general pattern with respect to water for drinking and sanitary purposes. The following situations are typical:

1. If a substantial portion of the process water is given a high degree of treatment (coagulation, sedimentation and filtration), the company usually will provide the added treatment (chlorination) needed to bring part of the supply to drinking water standards. This will require additional storage capacity and separate piping throughout the plant.
2. If the plant is in a rural or semi-rural location, the practice is to use wells for drinking water since the routine testing by health officials gives some assurance that the water is meeting minimum drinking water standards.
3. When a plant is located in or near the limits of the city, the usual practice is to have municipal water brought to the plant for drinking and sanitary purposes and thus eliminate possible liability and operating responsibility.

Secondary Water Sources

Most paper and textile companies which use large amounts of water usually operate on a twenty-four hour basis. These firms have highly developed secondary sources of water and/or storage facilities which enable them to operate on a continuous basis during extended period of low flow and droughts. The following are examples of the types of secondary water sources used in the state.

1. A company using the flow from a tributary as its primary water source maintains a stand-by pumping station on the main river. They then can pump water directly to the plant or storage facilities.
2. Pumping stations are maintained on smaller tributaries where water can be pumped to the plant or primary storage area (e.g. reservoir on a stream).
3. Municipal water supplies are a common secondary water source where a plant is in or adjacent to a city.

4. Wells with supplemental storage facilities provide an emergency source of water for short periods of time.
5. A private dam on a tributary may serve to augment the flow of the primary stream when rainfall and runoff are at a minimum.

Water Rights

Surface Water

Based on the industries studied, interest in riparian rights varies greatly. Large water users on relatively small rivers or streams, with a large investment in a plant and equipment, have substantial expenditures in land and water rights to insure so far as possible the right to use certain waters at current and future levels of production. On the other hand, some companies expressed no concern regarding water rights and any rights which they might have were acquired incidental to other facilities needed for the operation of their plant.

The reasons given by some company representatives for their lack of concern regarding surface water rights can best be summarized in the following general terms:

1. The plant is located on a large river and the amount of water now used and that which may be used in the foreseeable future is small in relation to the average stream flow or the lowest flow of record.
2. The economic climate for industry in a particular community is not good, whether it be "wet or dry." There would appear to be very few factors favoring additional industries locating in this area, so any investment in water rights would constitute insurance for a situation which is not likely to occur.
3. The water resources of the area are extremely small and those available are being used almost to capacity. It therefore, seems extremely unlikely that a large water user knowing these facts will locate in the area.
4. At a given location an alternate source of water can be developed at less cost than the purchase of surface water rights.

5. The construction of dams on major rivers has given a sense of security that low flows will be augmented during periods of low rainfall.

Ground Water

Interest in water rights for ground water sources likewise runs to extremes. In the case of large water users, underground flows have been thoroughly tested and substantial surface area acquired to lessen the possibility of adjoining property owners depleting the same stratum of subterranean waters. The reasons given by companies which expressed no real concern regarding ground water rights or lack of rights can be summarized as follows:

1. The company has a long history at this location. Even during periods of drought, the wells have not shown a significant drawdown. The anticipated level of production is not such that the water requirements will be materially changed.
2. The water requirement for the plant is relatively small and could be satisfied economically by water from a surface source or by the purchase of water from a municipality on a full time or stand-by basis.
3. A company's operation is not tied to a geographic location and, since their water requirements are small, moving the plant is economically feasible.
4. There is little economic incentive for another industry to locate in this area. The existing industry is at this particular site for historical reasons which are not now important.

Potential Sources of Conflict

The riparian doctrine provides that an owner of land abutting on a stream can make reasonable use of the water so long as he returns it to the stream substantially undiminished in quantity and quality. When there is an abundant supply of water of satisfactory quality, very little attention is given to the various uses made of water.

One obvious potential source of conflict arises from the drawing of large volumes of water from one river without returning it to the same river. North Carolina has several situations where water is thus

moved in quantity from one river basin to another.[35] An example is Burlington Industries, Inc. at Mooresville where the industrial water supply is obtained from one river basin and waste discharge is into another basin. If water should become scarce, more consideration will probably be given to the disposition of water in a river basin.

In 1958, Congress passed the Water Supply Act which authorized storage capacity in any reservoir project to be constructed by the Corps of Engineers in order to impound water for present or anticipated future demands or need for municipal or industrial water. The contract which formalizes the agreement between Corps and the participating agency may specify that a certain capacity between given elevations is available for withdrawal.

In North Carolina, Winston-Salem took advantage of this legislation to insure its future water supply at the time the Corps' project was planned for the Yadkin River at Wilkesboro. The agreement provided that Winston-Salem would have available 33,000 acre-feet between elevations 1000 and 1030. In consideration for this capacity the city was to pay approximately 11.63 per cent of the construction cost and about 17.93 per cent of the operating cost, the later to commence when the first withdrawal was made. The dam is located approximately 40 miles upstream from the city and the state law appears to leave unresolved the question of the rights of intervening riparian owners which may locate on the Yadkin River between the dam and the city. The Corps in the agreement specifically excludes any responsibility for the released water with the following clause:

> "The Government shall not be responsible for any diversion of waters released to the river, nor will it become a party to any controversy between users of the aforesaid storage space."

It is not unlikely that industries with riparian rights, located between

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[35]The following cities and towns are known to be involved in this type of water practice. The towns of Davidson and Mooresville obtain a minimum of 2.65 million gallons of raw water per day from the Catawba River Basin and discharge their wastes into the Yadkin River Basin. Kings Mountain obtains water from the Broad River Basin and returns part of the waste water (0.125 million gallons per day) to McGill Creek which is in the Catawba River Basin. The town of Blowing Rock secures water from a stream in the New River Basin but maintains a waste treatment plant which discharges into the Yadkin River. High Point takes water from a stream in the Cape Fear River Basin, permitting part of its waste to be discharged into the Yadkin River Basin. Kernersville has the opposite situation, takes water from the Yadkin River Basin and discharges

the dam and Winston-Salem, are looking to the waters from the dam as a primary or secondary source of water supply during periods of low flow.

Atypical Water Situations

The Pasquotank River Basin has been practically excluded from industrial development. This is due in part to a small labor supply and the scarcity of raw materials but also to the high salt content which makes the water economically untreatable for human consumption or industrial use by present treatment methods. At present there is neither a public nor an industrial surface supply located within this basin. While waters in the upper extremities of the main rivers provide some natural storage in the stream basin, this source has not been utilized because of the effect of wind tides on the unprotected sounds. This makes it difficult to predict the extent of the salt water intrusion and thus precludes a reliable water supply from this source. The population has relied on ground water sources for both domestic and industrial purposes. Ground water is presently obtainable in relatively shallow wells but there must be controlled pumping to prevent the intrusion of salt water into the fresh water formation.

This survey was conducted during a period when rainfall was less than the average and many industries were going to their secondary sources for water. The most critical situation found was with respect to an individual firm in the Charlotte area which was trucking water to a plant to supplement a well water source. Additional wells had been drilled in an effort to find a new underground source but each well developed only served to deplete the production of existing wells and a surface water was not immediately available.

Some cities attempt to attract industry on a rather indiscriminate basis, but the city of Greensboro has for many years officially or unofficially discouraged industries with a large water requirement. The city has developed its available water sources to a high degree. A new water

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waste into the Cape Fear River Basin. Only part of the waste from the towns of Star, Biscoe, and Candor is discharged into streams in the Yadkin River Basin. Asheboro is another city which has a water source on the Yadkin River but uses the Cape Fear River Basin as an outlet for its waste water. The city of Durham is located on the crest between the Neuse and Cape Fear river basins. Water is taken from the Neuse Basin but two of Durham's treatment plants are in the Cape Fear basin.

source may require the development at some distance and may entail joint arrangements with other municipalities or the Corps of Engineers.

Water and Waste Water Costs

In very general terms the cost of water to an industrial firm can be attributed to the following items of expense:

(a) Investment in riparian rights, other water rights, reservoirs, dams, storage lakes, inlet structures, right-of-ways, easements, etc. for surface water users and investment in surface holdings, storage structures, pumping facilities, etc., for ground water users

(b) Pumping stations, transmission lines, distribution systems and finished water storage

(c) Water treatment facilities

(d) Annual operating expenses (e.g. maintenance, labor, chemicals, power, etc.)

The first three items represent capital expenditures which can be reduced to annual operating costs by dividing the expenditure by the useful life of the equipment or the anticipated life of the plant in the case of structures or land holdings. Many companies were unable to accurately estimate their expenditures for item (a) since many of the elements were acquired at various periods during the history of the plant. In many cases the investment in water rights were part of or incidental to a larger purchase. Cost allocations in many cases were not made to the different benefits expected to accrue to the company by the purchase. The comparisions which follow are therefore based on only some of the companies studied. This sample is especially small in the case of industrial water wastes as many companies do not have complete operating units, were in the process of expanding or were not out of pilot plant stage.[36]

Table II shows the cost of water and waste water treatment for the three major industry groups in the state which have large water requirements and waste water effluents requiring treatment. The total cost of water appears to be related to the quantity used rather than the type of

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[36]Data on Industrial Waste Costs based on three paper companies, three textile companies and two food processing firms.

use, as the cost per unit volume (per thousand gallons) is lowest with the largest users. There seems to be some saving in handling large volumes of water as the largest cost per unit volume was highest in the food processing industry where the quantity used is lowest. In none of the three major industries was the cost of water significant in terms of total production cost. The effect of water on total production cost appears to be a function of the quantity used.

TABLE II - COSTS

Items	Industries		
	Paper	Textile	Food Processing
Annual Cost for Water	$15,000 - $330,000	$2,700 - $124,000	$850 - $7,750
Cost per 1000 gal. of Water	1.7¢ 3.75¢	2.7¢ 11¢	1.5¢ 28¢
Cost of Water as a Per Cent of Total Production Cost	0.27% - 0.7%	0.007% - 1.0%	0.005% - 0.1%
Annual Cost for Waste Treatment	$151,000 - $252,000	$11,000 - $150,000	$4,000 - $5,000
Cost of Water Treatment as a Per Cent of Total Prod. Costs	0.26% - 0.34%	0.5%	0.002% - 0.005%

Table III shows in a general way how the various factors which go to make up the total cost of water are different depending on whether a ground or surface water source is used. Investment in water rights and surface holdings is the largest single item in the cost of ground water but is very insignificant in the cost of surface water. The annual operating cost is extremely large in the case of surface water reflecting the relative purity of ground water sources. The range given for annual operating expenses related to ground water is probably misleading since the higher portion of the range reflects a few instances where the process water requires extra special treatment. The cost of treatment facilities and transmission mains does not appear to be very different between ground and surface water although the actual range of cost is slightly larger for surface water.

TABLE III

COST COMPARISON BETWEEN GROUND AND SURFACE WATER SOURCES

Items	Source of Water	
	Ground Water	Surface Water
1. Ratio of Water Rights Costs, etc. to Total Water Cost	39% - 58%	1.2% - 8.3%
2. Ratio of Transmission Line Cost to Total Water Cost	17% - 21%	1.1% - 18%
3. Ratio of Treatment Facilities Cost to Total Water Cost	15%	5.2% - 26%
4. Ratio of Annual Operating Expense to Total Water Cost	6.4% - 50%	65% - 85%

Note: Items 1, 2, 3, and 4 in Table III are ratios based on items (a), (b), (c), and (d) of page 49 being compared to the total cost of water.

Tax Relief

A North Carolina statute exempts industrial waste treatment and water pollution abatement plants and equipment from ad valorem property taxation and provides a five-year amortization allowance for income tax purposes in lieu of depreciation.[37] Both the property tax exemption and the rapid amortization allowance require certification by the State Stream Sanitation Committee before an industry can become eligible. The statute provides that ". . . said committee has found as a fact that the waste treatment plant or pollution abatement equipment purchased or constructed and installed . . . has actually been constructed and installed and that such plant or equipment complies with the requirements of said committee with respect to such plants or equipment, that such plant or equipment is being effectively operated in accordance with the terms and conditions set forth . . . by the State Stream Sanitation Committee, and that the primary purpose thereof is to reduce water pollution resulting from the discharge of sewage and waste and not merely incidental to other purposes and functions."

Approximately 12 firms have applied for and received certificates permitting them to amortize their anti-pollution facilities over a 60

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[37] G.S. 105-147.

month period.[38] This is a small per cent of those firms eligible to receive certificates by making application. Only nine of the twelve companies could be identified with certainty and of this number only three with a combined investment of $1,345,000 in anti-pollution facilities had actually commenced or completed the rapid amortization permitted under the statute. Three companies after receiving the certificates had elected to amortize over a longer period of time. Definite information on the other companies with certificates was not available--one having just received a certificate in the calendar year 1964.

It appears questionable whether the statute confers a significant benefit on the companies eligible to receive certificates as evidenced by the very small number making application and of the action by some to amortize over a longer period even with the certificate. The conclusion must be that the statute as related to rapid amortization has had little significance in the attainment of pollution control objectives.

Legislation

Historically water law has been a relatively undeveloped area of North Carolina's jurisprudence. The changing economy, intense interest in water recreation, and a rapidly expanding population may require a comprehensive water resource law if the people of the state are to continue to enjoy the benefits from the intelligent use of this resource.

Legislative changes might take the form which would modify the present riparian doctrine or a form closer to the appropriative doctrine followed in the western states. This study suggests that the following basic questions should be among those considered in formulating a comprehensive water resource law:

1. What are the rights of a municipality to provide surface water to non-riparian owners? If such a right exists with respect to domestic water use by its citizens, can it be upheld for industrial users in competition with industrial riparian owners on the same water source?
2. What are the rights of a municipality to water from a stream which is not adjacent to its property but on which the city does maintain a pumping station?

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[38]Based on the Biennial Reports of the Department of Water Resources and interviews with staff members of the State Stream Sanitation Committee.

3. What are the rights of an industry not contiguous to the river but maintaining an intake structure on it?
4. If the doctrine of reasonable use is expanded, how will this affect the rights of present downstream riparian owners? Should this give rise to a priority system between competing uses (manufacturing, irrigation, municipal water supply, recreation, waste disposal, etc.)?
5. Under what conditions will water be allowed to be moved from one river basin to another within the state?
6. Is some form of administrative tribunal necessary to administer some of these modifications and if so what form will it take?

These questions are not all inclusive but they are the ones suggested by the current industrial water practices evidenced about the state. All changes should be considered in terms of technological development as these may significantly affect and alter present water practices and trends in water use.

There are areas which influence the use and development of waters in the state other than those which are strictly related to water law. These situations will probably need a legislative policy determination. Any policy determinations in this area should be consistent with the concepts which might be expressed by changes in water law. Two situations which have become quite apparent are listed below.

1. The state may need to provide leadership and financing to implement the complete development of the whole river basin. Waters of the state might best be developed by comprehensive planning at the state level with implementation and control to reside at the local level. This should assist in preventing the uneconomical use of public moneys by individual governmental units concerned with an isolated problem.
2. Conflicts can arise over the preference to be given to the development of natural resources. A current example--shall the mining of phosphate, which will destroy a river in whole or in part, be preferred over the preservation of the river as a water resource.

Summary and Conclusions

1. The history of stream pollution control in North Carolina prior to the passage of the 1951 Stream Sanitation Law is a record of largely ineffective and unenforceable legislation. The new law has caused industries to make a critical review of their sources of water, their present and proposed water use patterns, and the quantity and quality of their industrial wastes in terms of operating processes.

2. The food processing industry, located in 83 of 100 counties, is showing continual growth. The water use for individual plants (between 0.04 and 1.0 million gallons per day) is not large. The source of water has been generally limited to wells and municipal supplies. The availability of water in the proper quantity and quality is not considered by most company officials to be a major consideration in site location. Cost of water varies between 0.1 and 3.0 mills per pound of product produced.

Historically, food processing plants have not treated their waste products. Very few plants are able to effect sufficient "in plant" changes to eliminate the necessity of treating their wastes. Most plants cannot rely on the assimilation capacity of the stream into which they discharge as the stream flows are very small during periods of greatest waste load. A very limited sample shows the treatment plants now in operation have an average cost of 1.0 mill per pound of production.

3. The paper and pulp industry is concentrated in seven companies, the oldest having located in the state in 1906 and the latest in 1951. These companies have a combined daily water use of 172 million gallons. One plant uses 45 million gallons per day and five use in excess of 20 million gallons per day. The large water requirement of the industry makes surface waters the most feasible source. The ground waters of the state have not been sufficiently studied to determine whether adequate supplies are available to provide for firms in this industry. Several of the paper companies, in an effort to assure so far as possible their present and future water supply, have invested substantially in riparian water rights. This is reflected in some of the costs for water which range from a few cents to several dollars per ton of production.

Of equal or greater importance to this industry is the availability of water for industrial waste disposal. Actual cost data for the plants in North Carolina are not available. Many company officials believe that the cost of treatment cannot exceed three to five dollars per ton of paper for the companies to remain competitive in both the United States and world market.

4. The textile industry is the leading manufacturing activity in the state and is represented in 78 of 100 counties. While the majority of the companies use surface water, smaller operations use wells or a municipal source. The general water requirements for the companies studied are between 0.5 and 27 million gallons per day. The cost of water varies from 0.007 to 1.0 per cent of the total production cost. Firms which reported water costs in terms of a pound of production have a range of 0.4 to 5.0 mills per pound.

Large water users have invested substantially in riparian rights while the small users feel that they have no present or future water problem, or that they prefer to solve the problem when it develops.

Traditionally, most firms in this industry have done very little treating of their wastes. The trend is toward aerated lagoons wherever possible. Some of the larger firms are using the activated sludge process. The costs for treatment based on a small number of companies are between 0.4 and 3.3 mills per pound of production.

5. Four private utilities provide North Carolina residents with most of their electric power. Some distribution is made through cooperatives which buy wholesale power from TVA. Four cities in the state maintain generating facilities and distribution systems.

The three major utilities have fifteen per cent of their total capacity in hydroelectric facilities. The other utility has a complete hydroelectric system serving five southwestern counties. Municipalities however, operate only steam generating plants.

The water for cooling the condensers in steam plants is taken directly from rivers. Some plants utilize cooling lakes while others return the water directly to the river. To date cooling towers have not been used in the state. The cost of cooling water does not usually exceed one or two per cent of the total cost of producing electric energy.

A minimum of sixteen towns and two industries are known to obtain their water supply from electric generating storage reservoirs. As the demand for water increases, requests to use these lakes either as a primary or secondary water source will probably increase.

Twelve industries have private generating facilities with capacities between 187 and 9800 kilowatts. Most of these firms expect to continue operating their facilities but plan no expansion.

6. The quarry operations throughout the state use water at the rate of 0.5 to 3.0 million gallons per day to remove silt and other foreign material. The plants are usually located on small streams which make the re-use of water a necessity. Most plants use a portion of their quarry as a settling basin before discharging the waste to the receiving stream. The cost of water for this operation rarely exceeds one cent per ton.

7. Some of the facts and factors which have evolved as the result of this study of industrial water users are as follows:

(a) The quantity of water is the dominant factor in determining the source of water used. A great preference is shown for the use of municipal water for drinking and sanitary purposes wherever it is reasonably available. Action by the Stream Sanitation Committee has stimulated interest in the re-use of water and caused most companies to make a critical review of their industrial wastes.

(b) Very few conflicts have arisen in the past concerning water rights although some current water practices appear to be at least in technical violation of the existing law. Most legislation has been concerned with the effect of water discharges. As the demand for water increases, these practices will be scrutinized more closely during droughts and periods of low flow. Among the problems which may eventually require comprehensive rather than piecemeal treatment are the following:

(1) Provision for moving water from one basin to another

(2) Rights of a municipality to use water from a stream if it is not a true riparian owner and the taking of water is in conflict with a riparian owner

(3) Rights of an industry taking its water from a municipal source as opposed to another industry on the same stream which is in fact a true riparian owner

(4) Rights of an industry or municipality to discharge into a lake wastes which do not cause a nuisance or health hazard but do impair certain recreational interests

(5) Rights of a municipality or industry to water from a stream where only a pumping station abuts on the stream and water is transported to the point of ultimate use.

There appears on the horizon at least two other situations regarding water rights capable of being resolved by either state or federal legislation.

(1) The first involves the rights of a riparian owner to waters which are released from a federal project when the storage of the water released was purchased by another downstream user.

(2) The right to divert water from projects licensed by the Federal Power Commission.

(c) The companies in the paper and pulp industry appear to be the only ones to have given primary attention to the availability of water in selecting a plant site. However, no information is available on industries which have passed up the state as an industrial location because of the unavailability of a good water supply. To date the quality of water has been a secondary consideration in the location of plants.

(d) The passage of the Stream Sanitation Law has had and will have in the future, a significant impact on the operating cost of "wet" industries in the state. This study did not attempt to evaluate whether the law has deterred many industries from locating in North Carolina or to what extent it has curtailed expansion. Company officials are quite aware that there are very few locations available in the United States which will not soon feel the impact of some regulation on industrial waste water discharge.

(e) Large water users (e.g. paper industry and electric generating plants) will locate only in areas where there is a satisfactory surface water supply. Food processors and some textile firms are much less dependent on water and can rely on ground water and municipal water sources. This permits much more flexibility in the selection of a plant location. If municipal water is available, there appears to be no set pattern as to whether an industry will use a private source or a municipal source for process water. Generally the selection is determined by economic considerations. Practically all companies go to a private source when the quantity of water needed exceeds 1.5 million gallons per day.

A P P E N D I X

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Albemarle Paper Manufacturing Company, Roanoke Rapids
Aluminum Company of America, Badin
American and Efird Mills, Inc., Mount Holly
American Enka Corporation, Enka
American Thread Company, Sevier
Beacon Manufacturing Company, Swannanoa
Becker County Sand & Gravel Company, Lillington
Biltmore Dairy Farms, Asheville
Burlington Industries, Inc., Greensboro
Cannon Mills Company, Kannapolis
Carolina Power and Light Company, Raleigh
Champion Paper Company, Canton
Charles F. Cates and Sons, Inc., Faison
Chatham Manufacturing Company, Elkin
Cone Mills Corporation, Greensboro
Cornell-Dubilier Electric Corporation, Sanford
Cranston Printworks Company, Fletcher
Dayco Southern, Waynesville
Duke Power Company, Charlotte
E. I. DuPont DeNemours & Company, Kinston
Elmore Corporation, Spindale
FCX Food Products, Lumberton
Federal Paper Board Company, Inc., Roanoke Rapids
Fiber Industries, Shelby
Fieldcrest Mills, Inc., Spray
Foote Mineral Company, Kings Mountain
Frosty Morn Meat, Inc., Kinston
Gerber Products Company, Asheville
Great Lakes Carbon Company, Morganton
Holly Farms Poultry Company, Wilkesboro
J. P. Stevens & Company, Inc., Wallace
Luck's Inc., Seagrove
Lundy Packing Company, Clinton
Lutz & Schramm, Inc., Ayden
Maola Milk & Ice Cream Company, New Bern
Maxton Oil & Fertilizer Company, Maxton
Mead Corporation, Sylva
Morgan Cotton Mills, Inc., Laurel Hills
Mount Olive Pickle Company, Mount Olive
North Carolina Finishing Company, Salisbury
Olin Mathieson Chemical Corporation, Pisgah Forest
Pittsburg Plate Glass Company, Shelby
Riegel Paper Company, Riegelwood
Sayles Biltmore Bleacheries, Biltmore
Southern Dyestuff Company, Mount Holly
Superior Stone Company, Raleigh
Thrift Dye Works, Paw Creek

Valdese Manufacturing Company, Valdese
Vel-Cord Southern Corporation, Lumberton
Virginia Electric Power Company, Richmond, Va.
Washington Mills Company, Mayodan
Watson Seafood and Poultry Company, Inc., Raleigh
Wellon Candy Company, Dunn
Weyerhaeuser Company, Plymouth

CLASSIFICATIONS FOR FRESH WATER STREAMS IN NORTH CAROLINA

Class A-I - Suitable as source of water supply for drinking, culinary, or food processing purposes after treatment by approved disinfection only, and any other usage requiring waters of lower quality.

Class A-II - Suitable as a source of water supply for drinking, culinary or food processing purposes after approved treatment equal to coagulation, sedimentation, filtration, and disinfection, etc., and any other usage requiring waters of lower quality.

Class B - Suitable for outdoor bathing and any other usage requiring waters of lower quality.

Class C - Suitable for fishing and fish propagation, and other usage requiring waters of lower quality.

Class D - Suitable for agriculture and for industrial cooling and process water after treatment by the user as may be required under each particular circumstance.

Class E - Suitable for navigation and may be used for the disposal of sewage, industrial wastes and other wastes but not to the extent of causing "offensive conditions" as defined in the Rules and Regulations to the Classification and Water Quality Standards.

PRIVATE POWER GENERATING FACILITIES

1. Is your power generating facility hydroelectric or mechanical?

2. Is the power generated directly from a river or from a canal? If from a canal, who owns the canal and what are the arrangements for use of the canal by your mill and others?

3. Do you intend to continue using the power plant indefinitely? Is any expansion planned? What per cent of your present power requirement do you presently produce?

4. What arrangements, if any, exist to serve your use of the water power from this generating site? For example, do you have any arrangements for leasing "mill power," or did you ever specifically acquire any water rights or rights to use a designated flow of water?

5. Do you use water for any other purpose connected with your mill such as, cooling, process, domestic, etc.? If so indicate the quantity for each general type. What is the source of this water?

6. If your installation operates under a FPC license, indicate the date and term of the license.

7. Has the company acquired any water rights separate from riparian lands in the vicinity of, upstream, or downstream from its reservoirs? Indicate nature and extent of rights acquired; also, how, when and for what purpose they were acquired.

8. What interests in land does the company own (nature and extent) in reservoir beds, areas upstream from reservoirs and areas downstream from reservoirs? How, when and for what purpose were they acquired?

9. Please identify and summarize any water rights litigation (or disputes settled out of court) involving the company and other water users.

10. To what extent are your reservoirs used for any of the following purposes:

    Municipal water supply? Industrial water supply? Irrigation? Swimming and fishing? Boating and navigation?

    What controls, if any, does the company exercise over each of such uses (for example--access control, contractual arrangements, etc.)? What conflicts or disputes, if any, have developed or are anticipated among competing uses?

Company Name _____

Surface Water Costs

Items	Annual Cost

1. Investment in riparian rights, other water rights, reservoirs, dams, storage lakes, inlet structures, rights of way, easements (total cost of all these items divided by either the life of the structure or life of the plant). . . . . $_____

2. Pumping stations, transmission lines and distribution system, finished water storage (total cost of all these items divided by the life of the equipment). . . . . $_____

3. Water treatment plant (total cost divided by expected life of the plant). . . . . $_____

4. Annual operating expenses (include maintenance expense, labor to operate facilities, chemicals used, pumping costs). . . . . $_____

Cost of Treated Water $_____

Cost of Water Purchased $_____

Total Cost of Water $_____

The total cost of water represents _____ per cent of the total production cost. [NOTE--THIS PERCENTAGE FIGURE WILL NOT BE USED SEPARATELY BUT WILL BE INCORPORATED IN A RANGE WHICH WILL INCLUDE ALL OF THE INDUSTRIES IN A GIVEN CLASSIFICATION.]

The cost of water per thousand gallons of water is . . . . . $_____
(Total cost of water divided by average annual water consumption expressed in thousands of gallons)

Industrial Waste Water Costs

Items	Annual Cost

1. Waste treatment plant including settling lagoons and appurtenant facilities (total cost of all items divided by estimated life) . . . . . $_____

2. Pumps, transmission lines, easements or rights of way for open channel flow (total cost of all items divided by life of equipment or life of plant) . . . . . $_____

3. Annual operating expenses (include maintenance expense, labor to operate facilities, chemicals used, pumping cost) . . . . . $_____

Total Cost of Treating Industrial Waste Water $_____

The total cost of waste water treatment represents _____ per cent of the total production cost. [NOTE--THIS PERCENTAGE FIGURE WILL NOT BE USED SEPARATELY BUT WILL BE INCORPORATED IN A RANGE WHICH WILL INCLUDE ALL OF THE INDUSTRIES IN A GIVEN CLASSIFICATION.]

Company Name _____

Ground Water Costs

Items	Annual Cost

1. Investment in surface holding to preserve ground water from being tapped, storage structures, development of well and the accompanying pumping facilities (total cost of all these items divided by either the life of the equipment or estimated life of the plant). . . . . $_____

2. Transmission lines and distribution system, finished water storage facilities (total cost of all these items divided by life of the equipment). . . . . $_____

3. Cost of equipment for treatment, if any, given to the water such as softening or chlorination (total cost of all these items divided by life of the structure or equipment) . . . . . $_____

4. Annual operating expenses (include maintenance expense, labor to operate facilities, chemicals used and pumping costs) . . . $_____

Cost of Ground Water $_____

Cost of Water Purchased $_____

Total Cost of Water $_____

The total cost of water represents _____ per cent of the total production cost. [NOTE--THIS PERCENTAGE FIGURE WILL NOT BE USED SEPARATELY BUT WILL BE INCORPORATED IN A RANGE WHICH WILL INCLUDE ALL OF THE INDUSTRIES IN A GIVEN CLASSIFICATION.]

The cost of water per thousand gallons of water is . . . . . $_____
(Total cost of water divided by average annual water consumption expressed in thousands of gallons)

Industrial Waste Water Costs

Items	Annual Cost

1. Waste treatment plant including settling lagoons and appurtenant facilities (total cost of all items divided by estimated life) . . . . . $_____

2. Pumps, transmission lines, easements or rights of way for open channel flow (total cost of all items divided by life of equipment or life of plant) . . . . . $_____

3. Annual operating expenses (include maintenance expense, labor to operate facilities, chemicals used, pumping cost) . . . . . $_____

Total Cost of Treating Industrial Waste Water $_____

The total cost of waste water treatment represents _____ per cent of the total production cost. [NOTE--THIS PERCENTAGE FIGURE WILL NOT BE USED SEPARATELY BUT WILL BE INCORPORATED IN A RANGE WHICH WILL INCLUDE ALL OF THE INDUSTRIES IN A GIVEN CLASSIFICATION.]

QUARRYING

1. Name and location of the plant _____
2. Are the principal products crushed stone, sand or gravel? _____
3. What is the average water requirement for the plant in million gallons per day? _____
4. What is the name of the stream from which the plant takes water? _____
5. If this stream is a tributary, of what other river? _____
6. If the plant is located on banks of a stream, how much stream frontage does the company own? _____
7. If the plant is not located along a stream or river, does the company own the water intake site? _____ If so, indicate the extent of ownership? _____
8. In situations where the plant is not located on a river, how is the water conveyed to the plant (pipe or open channel--gravity flow or pumping)? _____
9. Does the company own a right-of-way, have an easement or own in fee the land on which the pipe is located? _____
10. Can a simple sketch be furnished which shows the general location of the plant in relation to the water intake and point of discharge for the wash water? _____
If yes, please attach.
11. Does the company maintain a dam at the point of intake? _____
12. If a dam is maintained, is it small and thus merely facilitates getting the water into the intake structure? _____
13. Does the dam create a reservoir which constitutes surface water storage? _____
What is the capacity of this storage? _____
14. If a reservoir is created, is it used for recreational purposes? _____
If it is used for recreation, to what extent and are there restrictions on its use? _____
15. Is the water treated in any manner? _____
    a) What kind of treatment is given? _____
    b) What per cent of the water is treated? _____
16. Is any of your water supply obtained from a municipality? _____
    a) If so, which municipality? _____
    b) What is the water rate per thousand gallons? _____
    c) Is only water for sanitary purposes and drinking obtained from a municipality? _____
    d) What are the water requirements for purposes indicated in c) above? _____

e) Is a water connection maintained to a city supply for either emergency or fire protection purposes? _____ Explain _____

17. What is the cost of water in terms of a ton of rock, sand or gravel? (Compute by adding annual operating expenses to capital investment which has been amortized to an annual cost basis and divide by average annual production.) _____

18. What is the cost of water as a per cent of total production costs? ___

19. Do you anticipate any need for expansion in your water supply facilities? _____ If expansion is needed, indicate in a general way the direction which this expansion will take. _____

20. Into what river or stream is your wash water discharged? _____

a) Is it a tributary of a main basin stream? _____

b) Is it the same river or stream from which you obtain your surface water supply? _____

c) If the wash water is discharged into another river, is it in the same drainage area? _____

d) If not, into what other drainage basin is it discharged? _____

21. Does your present wash water discharge affect the stream classification of the river into which it is being discharged? _____

22. Is any treatment given your wash water other than settling? _____

a) If other treatment is given the wash water, describe in general terms. _____

b) What is the average amount of settling time for the wash water before it is discharged? _____

23. What is the cost of treatment in terms of a ton of production? _____

24. What is the cost of treatment as a per cent of total production costs? _____

25. What additional type of treatment is contemplated to prevent the wash water discharge from changing the stream classification? _____

TEXTILES

1. Name of the Company, Division or Subsidiary and address? _____

2. In general what are the principal products produced at the plant (e.g. cotton fabrics, rayons or nylons)? _____

3. What is the average water requirement for the plant in million gallons per day? _____

4. Is the water obtained from a surface source such as a river or reservoir? _____

   a) What is the name of the river or reservoir? _____

   b) Is the plant located on the river or reservoir and if so how much frontage (river or reservoir) does the Company own? _____

   c) If the plant is not located along a river, does the company own the water intake site? _____ If so, indicate the extent of ownership? _____

   d) In situations where the plant is not located on a river, how is the water conveyed to the plant (pipe or open channel--by gravity or pumping)? _____

   e) Does the Company own a right-of-way, have an easement or own in fee the land on which the pipe is located? _____

   f) Can a simple sketch be furnished which shows the general location of the plant in relation to the water intake and the waste water discharge? _____ If yes, please attach.

   g) Does the Company maintain a dam at the point of intake? _____

   h) If so, is the dam small and thus merely facilities getting water into the intake structure? _____

   i) Does the dam create a reservoir which constitutes surface water storage? _____ What is the capacity of this storage? _____

   j) Is the reservoir used for recreational purposes? _____ If so, to what extent and what restrictions are there on its use? _____

   k) Is there an official or unofficial limit on the amount of water that can be withdrawn from a reservoir by a private firm or governmental agency? _____ If so, explain. _____

   l) Is the water treated in any manner? _____

      1) What kind of treatment is given? _____

      2) What per cent of the water is treated? _____

      3) Is the cooling water treated? _____ What per cent of the water used is for cooling purposes only? _____

5. Is the water obtained from a ground water source? _____

   a) How many wells are in use? _____

   b) What is the capacity of the wells and what is their average depth? _____

   c) Have any wells gone dry or experienced substantial draw down during a drought period? _____

   d) How extensive is the Company land holdings overlying the ground water source? _____

   e) Has the Company acquired any ground water rights of neighboring landowners? _____

   f) If so, to what extent and the year of these acquisitions? _____

   g) Has the Company made any agreement with neighboring landowners restricting the rights of such owners to use ground water? _____

   h) Since the Company began using ground water, have they been involved in any litigation (or disputes settled out of court) with landowners or water users over ground water rights? _____

   i) Is the water given any form of treatment? _____

      1) If so, what kind of treatment? _____

      2) What per cent of the water is treated? _____

      3) Is the cooling water treated? _____ What per cent of the water requirement is for cooling only? _____

6. Is your water supply obtained from a municipality? _____

   a) If so, which municipality? _____

   b) What is the water rate per thousand gallons? _____

   c) Is only water for sanitary purposes and drinking obtained from a municipality? _____

   d) What are the water requirements for purposes indicated in c) above? _____

   e) Is a water connection maintained to the city supply for either emergency or fire protection purposes? _____ Explain _____

   f) Is the water treated in any manner? _____

   g) If so, what kind of treatment is given? _____

7. What is the cost of water in terms of a pound of finished product produced? (Compute by adding annual operating expenses to capital investment amortized to an annual cost basis and divide by average annual production). _____

8. What is the cost of water as a per cent of total production costs? ___

9. Do you anticipate any need for expansion in your water supply facilities? _____

   a) If so, in what respect? _____

10. What type of water storage facilities are utilized? _____

    a) What is the capacity of these storage facilities? _____

    b) What is the extent and capacity of water storage which is utilized for fire protection purposes? _____

11. Does the plant utilize any form of recirculation to conserve water use? _____ Explain? _____

    a) Are cooling towers or ponds utilized? _____

    b) What is the capacity of any tower or pond? _____

12. Into what river or stream are your industrial wastes discharged? _____

    a) Is it a tributary of a main basin stream? _____

    b) Is it the same river from which you obtain your surface water supply? _____

    c) If waste is discharged into another river is it in the same drainage area? _____

    d) If not, into what other drainage basin is it discharged? _____

    e) Have there been any major changes in the points of discharge for industrial waste in recent years? _____ If so, indicate briefly the extent of such changes. _____

13. Does your present industrial waste discharge affect the stream classification of river into which your waste is discharged? _____

14. What treatment, if any, is given the industrial waste water (general terms)? _____

15. What is the cost of this treatment in terms of a pound of production? _____

16. What is the cost of this treatment as a per cent of total production costs? _____

17. What additional type of treatment is contemplated to prevent the industrial waste discharge from changing the stream classification? _____

18. Based on latest engineering estimate, what will be the cost of treatment in terms of questions 12 and 13 above? _____

19. In recent years, has there been a change in emphasis of the finished product which increased or decreased the water requirements? _____ If so, explain. _____

    a) Has this change in emphasis affected the type of industrial waste produced?

20. To what extent have "in plant" changes improved your industrial waste discharge?

    a) Explain briefly the extent of these changes? _____

    b) Will these changes be self-liquidating over a small number of years? (In other words will the saving resulting from these "in plant" changes pay for the investment and operating expenses.)

21. Does a municipality treat the domestic waste? _____

    a) If so, which municipality? _____

    b) Is there a special charge for this service and if so, how much?

    _____

22. Does a municipality treat your industrial waste? _____

    a) If so, which municipality? _____

    b) Is there a charge for this service and if so, how much? _____

    _____

Form completed by _____
(name)

_____
(position or title)

_____
(mailing address)